

SCIENCE AND TECHNOLOGICAL INNOVATIONS AS DRIVERS FOR EDUCATIONAL CHANGE: TEACHERS' PERSPECTIVES OF AN INQUIRY-BASED PROJECT INTO THE UNKNOWN

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This study started in connection to two similar parallel on-going Teacher Development Programs (TPDs) in Sweden, within the PARRISE-project (2014-2017). It is a project funded by EU, where 18 universities from eleven countries cooperate to explore and develop ways to address political and ethical questions in science education, with starting point from Responsible Research and Innovation (RRI), embracing the SSIBL framework (cf. Levinson 2016). Preliminary results shows how teachers from the TPDs formulated mutual and competing aims concerning the role of science education regarding how to address the knowledge base of science in relation to new relatively uncertain areas. This is done in relation to innovation processes and their products as for example nanotechnology. Critical thinking and awareness of ignorance were formulated as important tools for a scientific literacy discourse of a more humbled view of knowledge production, connected to science research and innovation, and identifying conflicting interest from different actors.

Keywords: Science Education, Teacher Professional Development, Socioscientific Issues

INTRODUCTION

Aligned with the scientific revolution, there are challenges for education. Decisions related to the use of scientific innovations empower different progressions of economic, cultural, and social justice and therefore they need to be considered in ideological terms. Within every choice of knowledge-use and development there lies a decision that needs to be taken into consideration concerning its consequences. This means to bring in the political and ethical issues in relation to our society through the lens of science innovation. These issues carries uncertainties, contradictions, and conflicting interests (e.g. Lundegård & Wickman 2007; Hasslöf, Ekborg & Malmberg 2014). In line with those considerations, Latour (1999) talks about constructing a cartography of controversy. Analysing the controversies, uncertainties and risks of front science and innovation, along with the process of the knowledge construction (i.e. the different knowledge producers) might be a way to challenge our role as educators in science and technology. However, how to address this in relation to science education is not a straightforward process, and has troubled teaching practice as well as educational research for quite a while (e.g. Hodson 2011; Ideland & Malmberg 2015; Siomonneaux 2014; Zeidler et al. 2005). In relation to this for example Simonneaux (2014) discuss the training needs of the postmodern society and explores the complexity and dynamic approach needed to develop a socio-epistemological inquiry.

Scientific knowledge and scientific literacy could also be seen as a democratic privilege, which gives opportunities to citizens to critically consider the implications of scientific and technological development from different perspectives. In line with this reasoning, it also becomes important to reveal *the political* in science education and to be aware that scientific literacy is a form of political agency (e.g. Hodson 2011; Bencze & Alsop 2014). However, in what way the political has possibilities to emerge in science education and how this is approached in relation to students' agency as individuals in relation to existing discourses is an interesting question.

In the PARRISE project, a project funded by EU, (running through year 2014-2017, FP7; grant agreement 612438), 18 universities from eleven countries cooperate to explore ways to address those questions in science education. The overarching context of the project is Socio-Scientific Inquiry Based Learning

(SSIBL). SSIBL is based on three approaches often independently pursued in schools: Inquiry Based Science Education (IBSE), Socio-Scientific Issues (SSI) and Citizenship Education (CE), and the overall umbrella is Responsible Research and Innovation (RRI) (Levinson, 2016).

PURPOSES AND METHODS

This study started in connection to two similar parallel on-going Teacher Development Programmes (TPDs) within the PARRISE-project. The overall aims of these TPDs and PARRISE is to:

- raise authentic questions about controversial issues arising from impacts of science and technology in society
- integrate social and scientific inquiry to explore open-ended questions
- formulate solutions which help to enact change

The chosen theme of these TPDs with pre-service and upper-secondary general science teachers was to focus nanotechnology (the engineering of systems at the molecular or nanoscale level) in a societal perspective. Nanotechnology offers new products and is associated with spectacular innovative benefits for a substantial part of the societal future. However, at the same time future implications and risks of this technology and its products are very sparsely researched (Christensen 2009). Accordingly, the TPDs involved meeting active front researchers, scrutinising nanoproducts on the market to identify different actors and conflicting interests and to make brief lifecycle analyses. Furthermore, the participants of the TPDs planned how to address such teaching situations for existing and future classrooms within compulsory school. For the participants this involved to step outside the comfort zone of existing teaching and learning as reproduction of well-known knowledge, into uncertainty in a hardly documented area.

After completing the TPDs, we studied how the pre-service and in-service teachers talked about the societal role of science education starting from their experiences of the nanotech project during the TPDs. In 2016, there were three focus groups discussions. Two groups consisted of 4 respective 7 teachers and one of 5 pre-service teachers. The focus group discussions were conducted as semi-structured interviews (Kvale, 2009) by the authors of this paper, who also worked as teachers during the TPDs. The analyses are made by the first author of this paper. During spring 2017, new TPD courses are running. These participants will also be interviewed. The analyses as a whole will be done during spring 2017 and presented at ESERA in August.

The discussions so far have been analysed with methods inspired by discourse theoretical analysis (Laclau & Mouffe 2010; Hasslöf 2015), to explore the teachers' meaning making about the role of science education and their role as science teachers. The analyses were conducted in an iterative abductive process, where closed readings alternated between exploring the empirical data and identifying the over-arching categories formed by the aims of the TPDs. A special focus in the analyses were given to the science teachers' responsibility in science education to bring in:

- Concepts and critical thinking related to economic, social and environmental development
- Ethical concerns and political awareness
- Responsible research – economic and social aspects of innovation

The first step was to listen through all the interviews repeatedly to achieve a sense of the whole. Then, the interviews were listened through once more with the aim to capture utterances concerning central meaning of the teachers' reasoning in the area of the TPDs' aims. The related utterances around those issues were identified to analyse the central meaning of the discourse. In the next step the utterances were refined to analyse conflicts and similarities between different competing discourses of meaning. In this way the role of science education and the teachers' role in relation to e.g. their own and students' critical thinking were explored.

RESULTS AND DISCUSSION

The result and analyses takes its point of departure from the teachers' articulatory practice. The emerging discourses makes meaning from the participating teachers' experiences of the TPDs' nano-project. The main results from the first analyses shows how concepts as critical thinking, political awareness and responsible research partly formulates competing discourses, articulated differently by the in-service teachers and the pre-service teachers. The pre-service teachers show a more *postmodern discourse*, articulating how economic opportunities and different conflicting societal interests affect the research community and thereby bring about different prerequisites for which impact the results will have. The pre-service teachers show a more postmodern discourse, articulating how economic opportunities and different conflicting societal interests affect the research community and thereby bring about different prerequisites for research, and which impact the results will have. The science education is formulated as having an important aim to make the students competent to be aware of this process of knowledge construction. Examples of utterances formulating this discourse: "...also that science is potentially dangerous when we stop to listen to criticism, or stop to question, we need to have a discussion, it must be something that can be developed otherwise it is not science anymore". The in-service teachers' utterances on the other hand formulates a *reproducing discourse* of how the science education mainly should reproduce a scientific knowledgebase to be used as an important tool "to scrutinize the "right decisions" and make well-founded arguments."

Further, the in-service teachers articulate a more *positive approach* to front-science, highlighting the possibilities of innovation, and how the nanotechnology have increased the students' interests of science education. The formulations of increased interest are shared with the pre-service teachers', however, the pre-service teachers' utterances formulate a more *critical attitude* giving more attentions to uncertainty and risks of innovations.

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